Construction History in Spain: the Discipline's Foundation

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In the past two decades, Construction History has started to become an independent discipline. The number of articles, theses and books that could be assigned to this field has grown exponentially, and there have been several and remarkably successful congresses: 12 national (eight in Spain; two in France; one in the United Kingdom; one in Germany) and four international (Madrid 2003; Cambridge 2006; Cottbus 2009; Paris 2012) congresses, as shown in Table 1 further on. However, it is far from being a recognized discipline, such as Art History or the History of Science. There are no university chairs or departments and, in the reference databases, "Construction History" is not listed as a common descriptor. This is not surprising; it reflects the inertia of academia to accept new disciplines.

In what follows, we will discuss the current state of discipline in Spain. Previous articles have tackled the matter.[1081] We will try to avoid unnecessary repetitions and concentrate on: 1) The activities of the Spanish Society of Construction History and 2) its consequences on teaching and research, taking as a case study the experience in the School of Architecture of Madrid; also we will 3) give a provisional list of dissertations on Construction History read in Spain in the last 40 years.

First, we will try to define with the least possible ambiguity the field and objectives of Construction History. The intention is not to enter into the actual debate on the "definition" of Construction History,[109] but to show, in as detached a manner as possible, the ideas behind actions that have been made.

What is the history of construction?

Construction History is a chronological study of the techniques applied to the construction of architecture and civil engineering. There are two aspects: "history" and "construction". It is the second which defines this field of study. To construct (or build) is "to make (something) by putting together parts or materials". The construction itself is directed toward a practical purpose: building a house, a church, a bridge, a dam, etc. Good construction is an "art" (from the Latin *ars*, skill or talent), a "skill acquired by experience, study, or observation". Studying the art of building throughout history is the main objective of Construction History.

A digression
Before construction we must have a "design", a "project", a "plan". The master builder has

[108] The first author has contributed several times on the topic. S. Huerta, "Construction History in Spain: Some notes on its current state, historical origins and future perspectives", in *Construction History. Research perspectives in Europe*, A. Becchi, M. Corradi, F. Foce y O. Pedemonte (eds.), Firenze, Kim Williams Book, 2004, 43-59; "L'Histoire de la construction en Espagne: origines et état des recherches", in *Édifice et artifice. Histoires constructives (Recueil de textes issus du premier congrès francophone d'histoire de la construction. Paris, 19-21 juin 2008),* edited by R. Carvais et al., Paris, Picard, 2010, 65-75; "Historia de la Construcción: la fundación de una disciplina" in *A História da Construçao em Portugal*, edited by J. Mascarenhas Mateus, Lisboa, Almedina, 2010, 31-48.

[109] See: R. Carvais et al., "On Construction History", in *Nuts and Bolts of Construction History. Culture, Technology and Society*, edited by R. Carvais et al., Paris, Picard, 2012, Vol. 1, ix-xiv.

never ventured to begin work without a plan, without a project. In Spanish the equivalent for "design" is "proyecto", which has a wider meaning: it is "the idea of something to be done and how to do it" (This comes from the Latin "proicio" which means, literally, "to throw"). The keyword is "how"; this is the technical aspect. To project is to devise a complete plan and it involves a "jump", as there are infinite solutions to the same problem and it is impossible to calculate the consequences of every decision made. The design should not only include the form and disposition of the different elements which constitute the work, but also the way to actually build this work (a building, a bridge, a dam).

In any work of construction, many technical aspects are intertwined in a complex way (and technology is in the service of the architect or the engineer's ideas). Consider the building of a gothic church: It involved many different operations: surveying, soil mechanics, foundation design, centering, buttress and vault design, stereotomy, carpentry, lifting devices, water canalization, labour organization, etc. These are the modern keywords for some of the activities involved. The architect, master of the work, had to make decisions in all of these areas which were probably intertwined in a complex way. If we want to understand gothic design, we cannot put aside these technical issues.

Building services (water supply, heating, illumination, ventilation, air conditioning, etc.), though of ancient origin, took on great importance during the 19th century and are also part of Construction History. However, in the different national and international congresses that have been held, the number of contributions to these fields has so far been very limited.

We want to know more about all of these technical matters to better understand the final work. Choisy, the father of Construction History, rightly pointed out (referring to Roman construction): "Les édifices de l'antiquité ont été bien des fois décrits au point de vue de l'architecture, mais les détails de leur construction sont encore très-vaguement connus".[110] Too often in history of architecture books, grand conclusions have been extracted from false (or incomplete) evidence.

Construction History, therefore, completes these views, but does not enter into competition with other disciplines already established such as art, architecture, archaeology, social, economic, etc. histories.

An empirical "proof"

We may agree that a discipline, defined in a certain way, exists when a large enough number of publications during a long enough period of time can be assigned to it. This was the approach taken by the first authors in the 1980s. Spending three years collecting a long list of references pulled from the then-available (printed) catalogues, lists of handbooks and encyclopedias, bibliographies on the history of technology, etc., showed that the field was vast and rich, and that an enormous amount of information was dispersed among several established disciplines (books, handbooks and journals on architecture, engineering, archaeology, medieval studies, Asiatic studies, engineering, etc.). It was evident that many scholars and professionals asked themselves about the history of some technical aspects of their research or work fields. The projected bibliography was never finished, but the conviction that Construction History was a definite discipline guided all posterior work.

Dangers

[110] A. Choisy, *L'art de bâtir chez les Romains,* Paris, Librairie générale de l'architecture et des travaux publics Ducher et Cie, 1873, 1.

A newborn discipline is very vulnerable. It lacks a structure to protect it. Moreover, it is a very attractive field for members of other disciplines who see it as an unspoiled countryside, full of possibilities and, it must be said, where there are far fewer barriers. When a discipline is born, the academic bar is necessarily "low": little is known, and there lacks an organization of knowledge to facilitate reviews and criticism. George Sarton (1884-1956), who was fundamental in the formation of the History of Science, warned once and again about the dangers faced by a new discipline.[111]

The first danger is that no one, or almost no one, is asked to teach a class or deliver a conference on Construction History. To lecture on Michelangelo's painting at a prestigious university, you have to be a renowned scholar; at the same university, the task of imparting a conference on any topic pertaining to Construction History could be assigned to any teacher who ever manifested more than a vague interest in the discipline. We are paraphrasing Sarton who, in the 1940s, lamented such situations respecting the situation of the History of Science; and this was 30 years after the publication of the first journal of the History of Science (*Isis*, Vol. 1 published in 1913) and when, in some universities, there were already chairs in this discipline (Sarton describes the same situation in the context of the History of Art and Religion in the late 19th century).

The second big danger of an emerging discipline is "amateurism". At the beginning, the first researchers are necessarily enthusiastic amateurs. But this initial enthusiasm may have a negative effect if it is not moderated. To explain this, Sarton quoted Voltaire: "Mon Dieu, gardez-moi de mes amis! quant à mes ennemis, je m'en charge !" [God help me against my friends. I can take care of my enemies]. There are a number of Construction History enthusiasts, however, who think that this issue need not be considered. The enthusiast's genuine love of the discipline accepts uncritically any new contribution that appears; their ignorance of the literature lead them to believe that any occurrence represents an advance in knowledge.

Another misconception is to consider Construction History as any particular history about some of the activities involved in it. Individual histories always precede the general history of the discipline. Before starting to create the History of Science, there were many books published on the history of chemistry, of physics, of mathematics, etc. Moreover, many handbooks or manuals began with a historical introduction of the topic. Quoting, again, Sarton: "The history of science is much more than the juxtaposition of all the stories of the individual sciences, since its main function is to explain the interrelationship among them". The same can be said about the History of Construction. It is false that simply adding the insights offered by the history of woodworking, of stereotomy, of drawing and tracing, of practical geometry, of machines and cranes, of scaffolding, of lifts, etc., we will reach an understanding of the complex process of designing and building a simple Gothic vault.

The primary role of Construction History is precisely to show the relationship between all of these activities. In the same way that, while drawing an object (a sculpture, for example), we must move to capture different angles so as to understand its complete form, the construction historian cannot remain at a fixed point without risking a distorted view of the subject of study.

A discipline in its own right and for its own sake

Finally, we must insist that Construction History is not an "auxiliary science" without "a practical end". It has its own identity, and its study can be pursued purely for the sake of acquiring

[111] See: G. Sarton, "Introduction to the History and Philosophy of Science (Preliminary Note)", *Isis* 4, 1921, 23-31, and thirty years later, "Is it possible to teach the History of Science?", in *Horus. A guide to the History of Science*, New York, The Ronald Press Company, 1952, 44-66.

knowledge. It is true that its contents would be fundamental for anyone working seriously on the maintenance or restoration of historic buildings; that it will help the archeologist to understand findings and draw plans; widen the architectural historian's understanding… But its main purpose is not "to help" but "to know". This desire to know (which is at the origin of any science) about the building techniques of previous eras can be tracked throughout history, and this matter has already been discussed elsewhere. Finally, of course, construction occurs within a cultural and economic context, and this should be taken into account; but these aspects do not constitute the "core" of the discipline. We will now concentrate on the activities of the Spanish Society of Construction History in order to establish the foundations of the discipline and the results of these activities.

The Spanish Society of Construction History

The work to build the discipline of Construction History began in Spain in the 1990s. It was a deliberate effort born from the conviction that these studies, very numerous but dispersed in the most heterogeneous sources, formed a coherent field of knowledge. In previous articles, the origin of this idea and the probable causes of its warm acceptance have been discussed.[112] The purpose of the present paper is to succinctly show the Spanish experience in the last ten years. We are concentrating on the activities related to the establishment of Construction History as a discipline, and not to particular studies within this field.

In Table 1, the main activities of the Spanish Society (congresses and symposia) are noted within the context of main events related to Construction History in other countries. We believe that the determination to work constantly during the last two decades in order to establish Construction History as an independent and organized discipline is evident.

The main objective of the Society, as formulated in the Statutes of 1997, is to create a link between the different professionals and scholars working in Construction History in Spain, to promote and diffuse studies and research on the topic and to begin a discussion on the definition of the discipline itself. To achieve this some concrete objectives were defined:

1) the publication of books;
2) the organization of national congresses every two years;
3) the promotion of the study of Construction History through seminars and exhibitions;
4) the publication of a newsletter and a journal
5) the support of the discipline at a university level.

Books. The Instituto Juan de Herrera and the CEHOPU

The foundation of the Spanish Society was possible due to the support of two institutions: the Instituto Juan de Herrera and the CEHOPU [Centro de Estudios Históricos de Obras Públicas y Urbanismo]. The Society now has a firm relationship with the Instituto Juan de Herrera which helps in all organizational matters. The relationship with CEHOPU was intense and immensely productive while Antonio de las Casas was president. Since that time, it has diminished greatly. In any case, CEHOPU continues its activities within the restricted part of public works and civil engineering. The 1993 establishment, within the Instituto Juan de Herrera of a series of books on the history and theory of constructions, and the constant activity since then, has had, we believe, a significant impact on the discipline's diffusion in Spain (a list of books published in this series can be found in this article's Reference List).

[112] See note 1.

Table 1: Chronological register of main activities related to the building of Construction History as an independent discipline, with some emphasis on Spain

Year	Societies	Spanish national congresses on Construction History	International congresses on Construction History	Other national or international congresses and symposia	National symposia and other events
1982	Construction History Society (England)				
1985	Geschichte des Konstruierens (Germany, Research Project)				
1993				Symposium "Between Mechanics and Architecture" XIX, International Congress of History of Science (Zaragoza)	
1995					Grandes Bóvedas Hispanas (Madrid)
1996		1st (Madrid)		Symposium "Between Mechanics and Architecture" (Genoa)	
1997	Sociedad Española de Historia de la Construcción (Spain)			Symposium "Between Mechanics and Architecture" (Liège)	
1998	Associazione Edoardo Benvenuto (Italy)	2nd (A Coruña)		Symposium "Between Mechanics and Architecture" (Pescara)	
1999				Symposium in Honour of Edoardo Benvenuto (Genoa)	
2000		3rd (Sevilla)			
2001					"Guastavino. La rein-vención de la bóveda" Exhibition (Madrid)
2003			1st (Madrid)		
2005		4th (Cádiz)		Seminario internazionale teoria e pratica del costruire: saperi, strumenti, modelli (Ravenna)	Historical Perspectives on Structural Analysis, Simposio en homenaje a Heyman (Madrid)
2006			2nd (Cambridge)		
2007	Construction History Society of America (USA)	5th (Burgos)			
2008				Symposium "Between Mechanics and Architecture" (Rome)	
2008				Inaugural Meeting of CHSA (Atlanta); Premier congrès francophone d'histoire de la construction;	
2009		6th (Valencia)	3rd (Cottbus)	Construction History: A One-Day Exploration (Washington)	Auguste Choisy 1841-1909, Colloque Centenaire (Madrid)
2010	Association Francophone d'Histoire de la Construction (France)			History of Construction in the Americas, 2nd CHSA Biennial Meeting (Pennsylvania); História da Construçao em Portugal, Fundaçöes e alinhamentos, Lisboa.	
2011		7th (Santiago de Compostela)		Inventions: The Roles of Disaster and Industrialization in Construction History (New York)	Simposio Internacional de Bóvedas Tabicadas (Valencia)
2012			4th (Paris)	American Construction History, 1850-1950, CHSA's 3rd Biennial Meeting (Cambridge, MA)	Aprenent de la volta catalana (Girona); Albañilería vs. Cantería (Valencia)
2013	Gesellschaft für Bautechnik Geschichte (Germany)	8th (Madrid)		I Congresso Internacional de História da Construçao Luso Brasileira; Skyscraper History: Looking Back While Looking Up (Chicago)	
2014				Deuxième congrès francophone d'histoire de la construction; Baugerüste vom 16. bis ins frühe 19. Jahrhundert; Construction History Society: First National Conference; Primer coloquio mexicano de Historia de la Construcción;	Historia, arquitectura y construcción fortificada (Madrid)

			Construction History Society of America's Fourth Biennial Meeting (Minneapolis)
2015	9th and 1st Hispanic-American (Segovia)	5th (Chicago)	Construction History Society: Second National Conference

The congresses

The best way to gauge the state of the art of a "new" topic is, probably, to organize a congress. Historically, congresses have demonstrated their importance during a discipline's formative phase. There is no time for the long review process of journals, which is necessarily alien to new topics. If the event's diffusion is good in relevant circles (scholars, universities, professionals), then the response, i.e. the number of contributions presented, would give a good picture of general interest on the topic.

In Spain, we were surprised by the warm reception and the true interest which was evident during the first congresses. A full Main Hall at the closing event, all certificates and proceedings already delivered; these are very good signs, and these have been constants at all of the Spanish congresses (as well as the international congresses).

A congress is a meeting point of people with a common interest. Since the beginning, we have always considered congresses to be as such a place. We have not made any distinction among accepted papers (no poster sessions, no difference between recent graduates and old professors, etc.). The intention was to create the conditions for "something" to happen (even a disaster); to provide the place and the opportunity. Nothing else; as few preconceptions as possible.

It turned out that what happened was a great surprise: people who had been working in isolation, presenting "freak" historical papers at other congresses, found a community of authentic interest. This interest has remained, as is shown in Table 2, which lists the accepted communications in national congresses and seminars. It is interesting that since the beginning there have been foreign participants, mainly from Latin languages (Italian, Portuguese…).

The role of the Society and of the members of the Scientific Committee has been, of course, crucial. In some congresses, more than 50% of abstracts were rejected. The three main reasons for rejection are: 1) the contribution, though of a high standard, was not pertinent to Construction History; 2) low quality; 3) there was no place for all submissions (in a three-day national congress, it is not possible to accommodate in a convenient way more than, say, 150 presentations), and the criterion was the importance in the context of the development of the discipline.

After selection, it was the task of the director and the Organizing Committee to arrange the accepted papers in a more or less systematic way, into sessions. (Of course, this was not always possible and a few sessions, say 5-10%, were mixed).

Table 2: Spanish national congresses. Papers presented and published in the Proceedings. Foreign papers.

Congress	Date	Place	Papers	Foreign authors	Foreign /national rate
1	1996 (19-21 September)	Madrid	74	4	5%
2	1998 (22-24 October)	A Coruña	65	6	9%
3	2000 (26-28 October)	Sevilla	129	16	12%
4	2005 (27-29 January)	Cádiz	109	9	8%
5	2007 (7-9 June)	Burgos	93	8	9%
6	2009 (21-24 October)	Valencia	136	22	16%
7	2011 (24-29 October)	Santiago de Compostela	148	20	13%
8	2013 (9-12 October)	Madrid	109	17	16%

A consequence of the actual urgency for publishing was the reception of many multi-author abstracts. Quite often, the authors rotate throughout several abstracts of similar titles (sometimes evidently cut parts of a consistent whole) so that everyone is listed first in some abstract. Another situation that we have seen is that of a professor signing several papers with his/her PhD or graduate students. Aside from other (ethical) considerations, the artificial increase of papers was impossible to take on and, after the Fourth National Congress, we decided to accept only one person per contribution, i.e., only one person could sign (alone or with others) one paper. This has the beneficial effect of reducing redundant papers and, also, of giving independence to some young researchers.

All of the Proceedings were printed and ready for the congresses thank to the support of the Instituto Juan de Herrera. All the contributions are on the Society's website in PDF format, free to download.

Teaching Construction History

Teaching a new discipline always presents problems. On one hand, the information available to the teacher is irregular and scattered, lacking the critical apparatus necessary to adequately prepare lessons (manuals, bibliographies, reference guides, etc.). This problem worried Sarton during his whole career; he dedicated four papers to discussing methods and problems, spanning from the beginning of his professional involvement in the History of Science to one of his last books, *Horus*.[113]

[113] Sarton published four essays on the teaching of the History of Science: G. Sarton, "The teaching of the History of Science", *The Scientific Monthly* 7, 1918, 193-211; (second article) *Isis* 4, 1921, 225-249; (third article) *Isis* 13, 1930, 272-297, and the already cited "Is it possible to teach the History of Science?", see note 4.

The next question concerns the selection of teachers.[114] What requirements should a teacher of Construction History have? Of course, he or she must have a technical background; without it, it would hardly be possible to interpret and understand various sources and then explain them to students. The teacher need not be a specialist in a particular field (carpentry, ancient mortars, stereotomy, bridges, etc.); ideally, he or she would be an expert in some particular field and have general background on the rest of the topics which inform the discipline.

Thirdly, the lecture syllabus should cover, chronologically, a broad span of time (say, from Antiquity to the Middle Ages, or from the Renaissance to the 19th century). As previously mentioned, the discipline of Construction History is much more than the sum of the individual histories on particular topics. Thus, although this involves considerable work, the teacher of Construction History must necessarily enter fields that may not match their field of specialization.

In the same way that a professor of art history covers, for example, the time from Antiquity to the Renaissance in a standard semester (depending on schedules, etc.), but perhaps is specialized in Impressionist painting, the teacher of Construction History should try to cover a similar period of time and a sufficient number of constructive aspects which enables students to understand the development of the whole art of construction. If specific periods or particular activities are the actual subject of the course, then this should be clearly stated in the title: it is understood that if the title is "Art History" students should not find a course whose actual content is "Florentine Renaissance painters".

Finally, a discipline is not a simple sum of independent lectures taught by different teachers. Due to the difficulty of the task, it becomes an almost irresistible temptation to chop the field into the same number of classes as available teachers. It should be stressed that this is a great danger because it makes it impossible to reach the desired degree of coherence; besides, the students may suspect that the syllabus suits not their needs but the teachers' convenience.

This last comment refers to graduate studies. Of course, postgraduate and doctoral studies must necessarily be specific. The purpose of that work is original research. To do this, the researcher must know exactly what has been published in the restricted field of research chosen. It is essential to know research techniques and develop an instinct for locating the most relevant sources. As has been said, this is particularly difficult in the field of Construction History, and the teacher should, both in undergraduate and postgraduate courses, introduce students to the intricacies of documentary sources.

The lack of an adequate research apparatus, formed by (specific and general) bibliographies and reference guides makes the task difficult today and uncertain even for specialists.

Teaching Construction History in Madrid, 1998-2014

The new plan for studies in the School of Architecture of Madrid in 1996 offered the possibility to propose optimal syllabi. Madrid had been chosen as a case study for authors' ease of access to information. As will be seen when speaking of dissertations, the universities of Sevilla, Valencia and Barcelona also have been very active since the 1990s.

Two syllabi forming a complete set of lectures on Construction History were proposed: "Construction History I: from Antiquity to the Middle Ages" and "Construction History II:

[114] Sarton made also clever remarks about this topic: G. Sarton, "Qualifications of teacher of the History of Science", *Isis* 37, 1947, 5-7; (second article), *Isis* 40, 1949, 311-313.

from the Renaissance to the 20th Century". The initiative came from three professors, S. Huerta, E. Rabasa and the late L. Villanueva, and from different departments (Structural Design, Graphic Ideation and Architectural Construction). The teaching of CH-I began in 1998-1999 and in 1999-2000 the next course, CH-II, both of which continue to today.

Each syllabus, CH-I and CH-II, consisted of 50 hours of teaching and seminars over 14 weeks. The total is, then, 100 hours in a course of 30 weeks divided in two semesters. Three weeks per semester were reserved for seminars, exposition of student work and exams. This leaves a total of 11+11 = 22 weeks for lectures. The hourly assignation for lectures was three hours per week. In the schedule, lectures were delivered the same day: two lectures of 1.25 hours, leaving half an hour's rest in-between.

The division into two courses was forced by the plan's structure and the limited number of teachers available at the beginning, but the intention from the beginning was to produce a complete course on Construction History from Antiquity to the 20th century. This led, eventually, to dispersion in teaching: several teachers participated and, for convenience, over the years some teachers specialized in different topics (Roman or Greek construction, stereotomy, etc.).

The first author always thought that a teacher of Construction History should be able to deliver most of the lectures of both syllabi. In this way, students, at least, receive a more or less coherent system of lectures. In Table 3 an outline of the program for the 2005-2006 course is given. It was the only time that both syllabi were taught as a whole; usually, the syllabi have been taught in separate groups.

Table 3: A syllabus on Construction History for graduate students of the fourth and fifth years in the School of Architecture of Madrid (Huerta's 2005-2006 course)

History of Construction

Part I: From Antiquity to the Middle Ages
Mesopotamia and Ancient Near East
- General. Prehistory. The invention of the brick.
- Brick constructions. Walls, temples. Transport of colossi.
- The invention of the arch. Vault construction. Tombs.

Ancient Egypt
- General. Materials: wood, brick, stone.
- Temple construction.
- Vaults in Egyptian architecture.
- Obelisks: extraction, transport and erection. The transport of colossi.

Ancient Greece
- General. Materials: wood, brick, stone. Procedures.
- Temple construction. Machines, auxiliary methods.
- Temple structure: foundations, walls, columns, lintels, roofs.
- Vaults in Greek architecture. Greek cranes.

Ancient Rome
- General. The invention of the Roman concrete. Walls and foundations.
- Vaulting. Theories about Roman vaults.
- The Pantheon and the Therms.
- The treatise of Vitruvius.

Byzantium

General. Materials: wood, brick, stone. Wall construction.
Vault construction without centering. Barrel and groined vaults.
Vault construction. Domes. Wooden chains. Buttressing.
Hagia Sophia. Design and construction. Influence.

Islamic architecture

General. Materials. The arch and the barrel vault. Complex vaults. Towers and bridges.

Middle Ages

Romanesque and gothic construction. Materials and auxiliary methods.
Vault erection. The gothic structure.
Medieval structural design. Late-gothic manuals.

Part II: From the Renaissance to the 20th century

Renaissance

24. The construction of the dome of Santa Maria del Fiore.
25. The architect. Design methods. The treatise of Alberti.
26. The building of El Escorial (A. López).
27. Form and construction of Renaissance domes. Saint Peter's dome.

The 17th and 18th centuries

28. Construction in wood. The carpentry treatises. Empirical beginning of scientific calculations (I. Gómez).
29. The birth of scientific structural analysis. From Galileo to Coulomb.
30. Baroque and late-baroque domes. Oval domes. Guarini.
31. Theory of masonry arches and vaults in the 18th century: from traditional to scientific design.
32. Building construction in Spain: the treatise of Fray Lorenzo de San Nicolás and its influence.

The 19th century

33. New materials: cast iron. Use in buildings and bridges.
34. New materials: Wrought iron. Tensile joints and new trussed structures.
35. Great roofs. Structural theory of trussed structures. Plane and spatial trusses.
36. Origins of framed construction. Industrial and office buildings.
37. Skyscraper construction (end of the 19th century, beginning 20th century).
38. New materials: the invention of reinforced concrete. First applications and tests.
39. Masonry vault and dome theory.
40. Tile vault construction: the work of Guastavino in Spain and America.

The 20th century (until ca. 1950)

41. Reinforced concrete. Building frames, first shells, bridges.
42. Design of thin shell roofs. The work of F. Dischinger.
43. The structures of Torroja (J. Antuña).
44 Tensile structures: from their beginnings to Frei Otto.

The preferences of the first author are evident, as are an intent to cover the whole historic range. The difficulty in preparing the lectures depended on the available literature: Rome and the Middle Ages were easy, the difficulty being more in making a selection among the abundant literature; about Islamic construction there is, as far as I know, no comprehensive handbook published yet, and the information had to be obtained by consulting numerous individual chapters of books, articles and dissertations. The program has defects and is exposed only as an example of actual teaching of the discipline.

It will be noted that, in the first part, the pattern of the lectures is more systematic, always incorporating the following parts: 1) general; 2) materials (brick, stone, etc.) and tools; 3) elements (walls, columns, vaults, etc.); 3) auxiliary means and building activities (cranes, scaffolding, transport, etc.); 4) building types (temples, churches, towers, etc.); 5) design

procedures.

In the second part, it was found to be quite difficult to follow the same approach. Paradoxically, the abundance of printed information (the treatises) has lead to fewer general studies on building construction. It was decided to cover the periods by studying central topics (carpentry, masonry mechanics, etc.) or particular buildings (Santa Maria del Fiore) or types of buildings (baroque domed churches). In the 19th century, the appearance of "new" materials (cast and wrought iron, reinforced concrete, steel) and "new structural types" (continuous beams and frames, plane and spatial trusses), together with the formation of classical structural theory, almost give the lecture titles. The 20th century is a continuation with two new structural types: thin shell and tensile structures. Monographic studies on builders or treatises are interspersed.

The students were all graduates of the last courses (mainly in the fourth and fifth years of the five-year program in architecture). There was "research" course work on some particular topic. The students (in groups of two) were assigned a topic for which to prepare a brief research work. In Table 4, a list of topics for the first part (CH from Antiquity to the Middle Ages) is shown. Of course, the intent was not that the students do original research, but that they become familiar with documentation on a certain, concrete topic, acquire a limited amount of documentation (from a limited number of sources) and, then, be able to study this material critically and, eventually, to show the results of this critical study in a systematic way.

Table 4: Examples of topics of "research" for student work in Construction History I (2006-2007 course, Huerta)

1.	Transport of colossi and obelisks in ancient	13.	Viollet-le-Duc and medieval rationalism
2.	Arches and domes in Greek architecture	14.	The design of Milan Cathedral
3.	Statics of Greek temples	15.	The construction of medieval foundations
4.	Use of iron in Greek construction	16.	The practical geometry of medieval builders
5.	The architect in Roman times	17.	On the layout and function of Gothic ribs
6.	The structure of the Pantheon	18.	The structure of Gothic cathedrals
7.	The construction of Roman bridges	19.	The origin of flying buttresses
8.	The education of Byzantine architects	20.	The role of flying buttresses
9.	The structure of the dome of St. Sophia	21.	Construction of Spanish medieval cimborios
10.	Geometry: theory and practice in 11th Persia	22.	The education of the medieval architect
11.	The structure of the Mosque of Cordoba	23.	Fan vaulting: geometry and construction
12.	Hispanic cross-arched vaults	24.	The collapse of the Beauvais Cathedral's vaults

There were some lectures on sources and information research and intermediate seminars. At the end of the course, the groups would present their work orally (20 minutes) and also give written work (but not a printed form of the presentation!). Some years, a brief multiple-choice test of basic questions was given, to gauge the general level of assimilation.

The result has been most satisfying. Most students showed a great interest, and some every year did remarkable work. It should be understood that the objective was not original research, but to show the students the problems of facing limited research. The field was already covered but the students worked with limited time and, necessarily, documents. Nonetheless, every year some two or three presentations (out of, say, 20) were very good. Some students also at times showed great ingenuity (for example, using cardboard models to study and understand Islamic geometric problems or vault geometries).

In Table 5, the number of students who have participated in each of two the parts of Construction History is given.

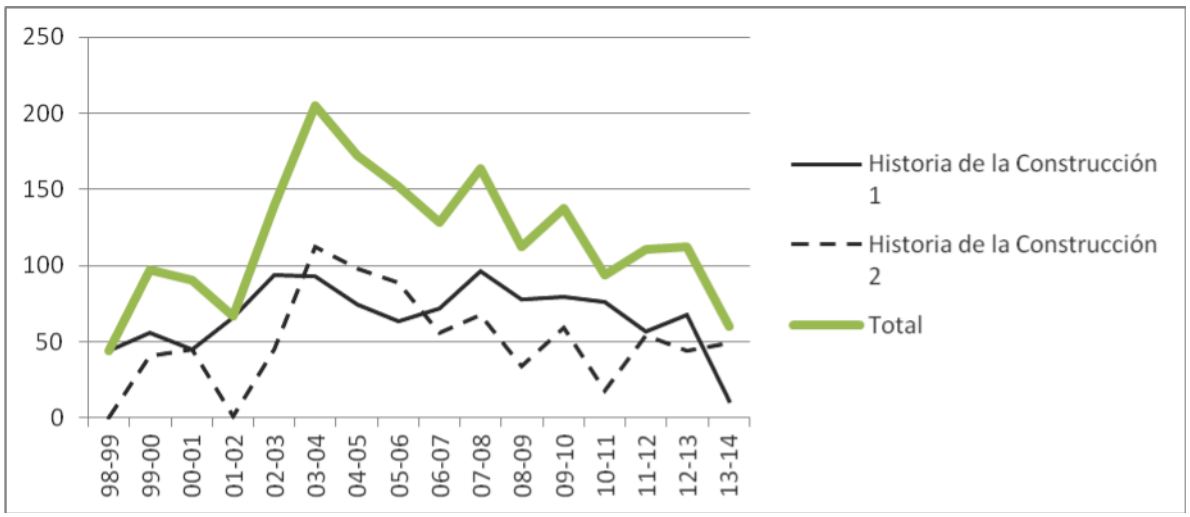
Table 5: Number of students enrolled in the Construction History courses

Course	Construction History - I	Construction History - II	Total
1998-99	44	-	44
1999-00	56	41	97
2000-01	45	45	90
2001-02	66	1	67
2002-03	94	45	139
2003-04	93	112	205
2004-05	74	98	172
2005-06	63	89	152
2006-07	72	56	128
2007-08	96	68	164
2008-09	78	34	112
2009-10	79	59	138
2010-11	76	18	94
2011-12	57	54	111
2012-13	68	44	112
2013-14	11	49	60
Total	1072	813	1885

In the last 15 years, an average of 120 students per year has taken a course on Construction History. This was the result of the efforts of a group of teachers. As the syllabi were optional, this number reflects students' sustained interest in Construction History.

The bad news is that the new plan for 2010 removes the optional syllabi, and the formal teaching of Construction History at the School of Madrid would probably disappear. Though the situation is not stable, it appears that only some workshops on very particular aspects of Construction History will be taught. In the last course, the following were given: carpentry, tile vaulting, stereotomy and gothic vaulting.

This situation should be a warning about the fragility of a new-born discipline like Construction History.



Dissertations on Construction History

The search for doctoral dissertations on Construction History is neither easy nor immediate. In the main, official research portals, there is not an independent label or keyword for "construction history". So, it is necessary to search through other words belonging to the Thesaurus, such as architecture, history of architecture, construction technology, geometry, technology sciences, specialized histories, technology history, etc. Some dissertations have been found through some keyword in the titles: construction history, constructive analysis, vault, dome, *montea* [trace], masonry, stonework, stereotomy, brick work, rammed-earth, *tapiería* [rammed-earth craft], castle, fortification, military engineer, woodwork, *lazo* charpentry, *carpintería de lo blanco,* industrial architecture, enginery history, railway, etc. The main web searches for information about doctoral theses in Spain are:
- Teseo: Web of the Ministery of Education, Culture and Sport. It has the biggest database of doctoral theses read in Spain.
- TDR [tesis doctorales en red - online doctoral theses]: Cooperative repository of digital doctoral theses read in Catalunya and other regions of Spain.
- Dialnet: Database created by La Rioja Univesity in which can be found the doctoral theses of 45 public Spanish universities.

However, we have detected that these databases are not entirely trustworthy before, say 2000; some dissertations are missing, or present in one but not the others.

It was impossible to consult most of the dissertations. The selection has been made considering the title and the abstract (when available). Also, some dissertations were cited in books. This list should be considered, then, as provisional, giving an idea of the development of research in this field in the last 40 years in Spain.

In any case, the research has revealed a result of about 90 dissertations read in Spain in the last 40 years (1974-2014). It is possible that the number could be higher due to search restrictions, but at least is significant and representative. It may be, also, that a detailed inspection of their contents would lead to some of them being discarded.

In Table 6, we can see the result of grouping dissertations by periods of five years.

Period	Diss. Read
1974-1985	3
1986-1990	11
1991-1995	9
1996-2000	13
2001-2005	15
2006-2010	14
2011-2014 (through Sept.)	27
Total	92

Table 6: Number of dissertations on Construction History read in Spain, 1974-2014. Distribution by periods of five years.

Spectacular growth can be appreciated in the last years. This may be explained by the discipline's success. Another factor may have had an influence: since 2007, Spanish university rules have shortened the period given to write a dissertation to three years and, also, having a PhD is now the first step in an academic career. Finally, the "quality assessment" of the universities takes into account the number of dissertations read, not their actual quality.

In Table 7, the distribution by university is shown.

University	Diss. Read
Politécnica de Madrid	22
Politécnica de Catalunya	20
Politécnica de Valencia	9
Sevilla	6
Complutense de Madrid	4
Autónoma de Madrid	3
Barcelona	3
Valladolid	3
Autónoma de Barcelona	2
Girona	2
Salamanca	2
Navarra	2
Granada	2
Zaragoza	2
Alicante	1
Oviedo	1
Castilla-La Mancha	1
Ramón Llull	1
Valencia	1
Jaume I de Castellón	1
Total	92

Table 7: Number of dissertations on Construction History read in Spain, 1974-2014. Distribution by university.

Conclusions

Construction History is a discipline in its own right as it serves to explain and understand one of the oldest human activities: building construction. The awakening attention to this field, the growing number of publications, the demonstrated activity at congresses, etc., should make us optimistic about the future. However, this promising future will only become a reality if we work with a full awareness of the dangers and difficulties of building a new discipline.

The first task will be to achieve full university status, with core, full-time teachers, researchers, departments and research institutes. The difficulties concerning the training of teachers and formulation of syllabi have been very briefly discussed. They should be the matter of personal and collective (congresses, symposia) reflection and discussion in the future.

The second task is to form the critical apparatus of bibliographies, critical editions, detailed studies, reference guides, etc., which would place these different subjects within the discipline's context. This will improve understanding and, especially, eliminate errors and avoid repetitions.

Finally, a considerable work of original research is needed. This involves very hard work; as previously mentioned, a lot of effort must be dedicated to knowing the state of the art in every particular part of Construction History. We are breaking new ground; there is much to explore and discover. But the difficulties of an emerging discipline are almost insurmountable, when agencies on research quality arbitrarily require immediate publication "impact".

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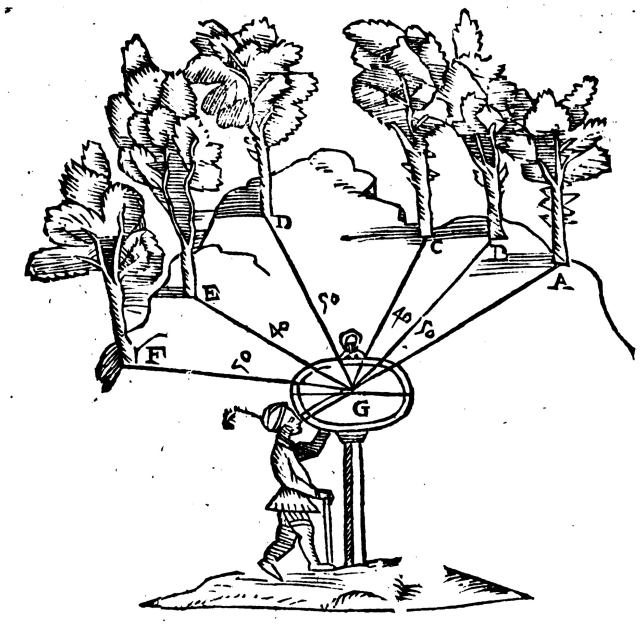

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À Joël Sakarovitch,
savant européen,
et ami…

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